8

The Fuel and Power Resources of the West Gippsland Region

By C. S. Gloe*

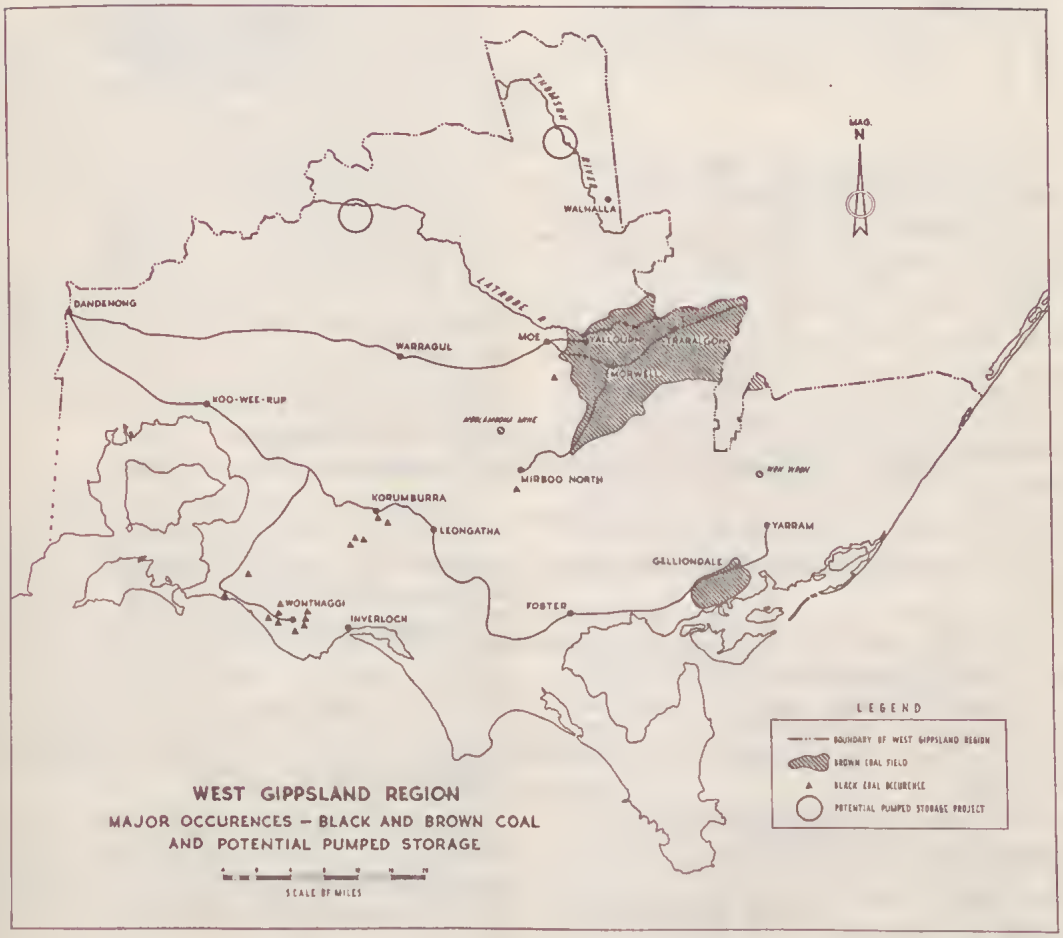


Fig. 1

INTRODUCTION

Readily available indigenous fuels have played an important part in the high level of industrial development achieved in Victoria. Those fuels concerned are the hard or black coals of South Gippsland and the brown coals of the Latrobe Valley—two areas occurring within the West Gippsland Region.

Just offshore from the West Gippsland Region and extending to the east is the Gippsland Basin in which significant finds of oil and gas have been made over the last few years.

* Geologist-in-Charge, Planning & Investigation Department, State Electricity Commission of Victoria, Monash House, 15 William Street, Melbourne, Victoria 3000.

Prior to 1910, local firewood and black coal from New South Wales were the chief fuels used to provide energy for power, heat, transport, etc., in Victoria. Following a prolonged strike of miners in the Newcastle field of New South Wales, the State Coal Mine of Wonthaggi was opened in 1909. Up until 1930 some 11,000,000 tons of black coal were obtained from this source and ensured a supply of coal for the Victorian Railways.

Over the past 40 years the opening up and development of the brown coal deposits in the Latrobe Valley has played a dominant role in meeting the energy requirements of Victoria (Chapman, 1967). It is likely that this fuel, together with the newly discovered oil and gas, will provide the basis for the continued growth of Victoria for many years to come.

BLACK COAL

The principal localities where black coal has been mined in the West Gippsland Region are Wonthaggi, Korumburra, Jumbunna, Outtrim, Kilcunda, Woolamai, Berry's Creek, Boolarra and Coalville (Thomas, 1968.) (Fig. 1.)

The coal occurs in Mesozoic rocks, which according to recent palynological investigations are now considered to be of Lower Cretaceous age. It would appear that the coals developed in a number of discrete basins of sedimentation. They are interbedded with felspathic sandstones and mudstones, both of which exhibit current bedding. Edwards, Baker and Knight (1944) favoured a drift origin for the coal although it was considered that some in-situ growth could also have occurred.

These are banded bituminous coals with medium moisture contents, but relatively high ash contents. Although less efficient than the coals of Newcastle, the Gippsland coals are generally good steaming coals. They are, however, unsuitable for gas making, and, with minor exceptions, are non-coking.

Apart from the question of quality, the Gippsland coals proved more expensive to mine than the New South Wales coals. Two main reasons were the general thinness of the seams and the extensiveness of faulting. The latter produced fault-bound blocks, each of which had to be mined as separate units, but, in addition, resulted in numerous lesser displacements throughout each block.

Because of the high production costs, the coal mines were closed down in 1968, and at that time the total black coal production in Victoria had reached 22,338,000 tons. Most of the coal was mined between 1910 and 1930, during which time rates of production ranged from about 400,000 to just over 700,000 tons per annum. After 1930, production rates gradually declined. It has been estimated that reserves at Wonthaggi total 6,660,000 tons. In other areas total reserves are estimated at 2,340,000 tons.

The State Coal Mine was reopened in 1969 by private interests, but the quantities of coal being mined are small.

The black coals of South Gippsland were used mainly by the Railway Department of Victoria. Some coal was burned in power stations such as Newport and Wonthaggi, and it was used also for industrial and domestic purposes.

BROWN COAL

The major deposits of brown coal in the West Gippsland Region are located in the Latrobe Valley and in the Gelliondale-Welshpool area (Fig. 1). Lesser deposits have been reported from a number of localities (Thomas and Baragwanath. 1949) but the only attempt at exploitation has been from the Thorpdale-Childers area.

Latrobe Valley

In the Latrobe Valley Depression thick brown coal seams of the Upper Latrobe Valley Coal Measures underlie an area from 5 to 10 miles wide extending over a length of more than 30 miles from near Yallourn in the west to just south of Sale in the east. Much of this area falls within the West Gippsland Region.

Geology

The detailed stratigraphy and structure of the Upper Latrobe Valley Coal Measures within this coal field have been described by Thomas and Baragwanath (1949-1951), Gloe (1960, 1967). This sequence of sediments has a thickness of about 2,200 ft in the eastern portion of the Depression where all three seams or groups of seams are fully represented. However, in the Yallourn-Morwell area the lowermost or Traralgon group of seams is missing and the section is only some 1,500 feet thick.

The complex splitting of the Morwell group of seams in the Yallourn-Morwell Field is shown in the diagrammatic section (Fig. 3). The relationship of the individual open cuts and the coal seam in which they are being operated is also shown.

Early Investigations

Only two outcrops of coal seams from the Upper Latrobe Valley Coal Measures are known in the Latrobe Valley, and both are located near Yallourn. One, known as Davis's Seam, occurs well above river level in the Latrobe River gorge about one mile upstream from the Yallourn Power Station, and was worked in 1874. The sec-

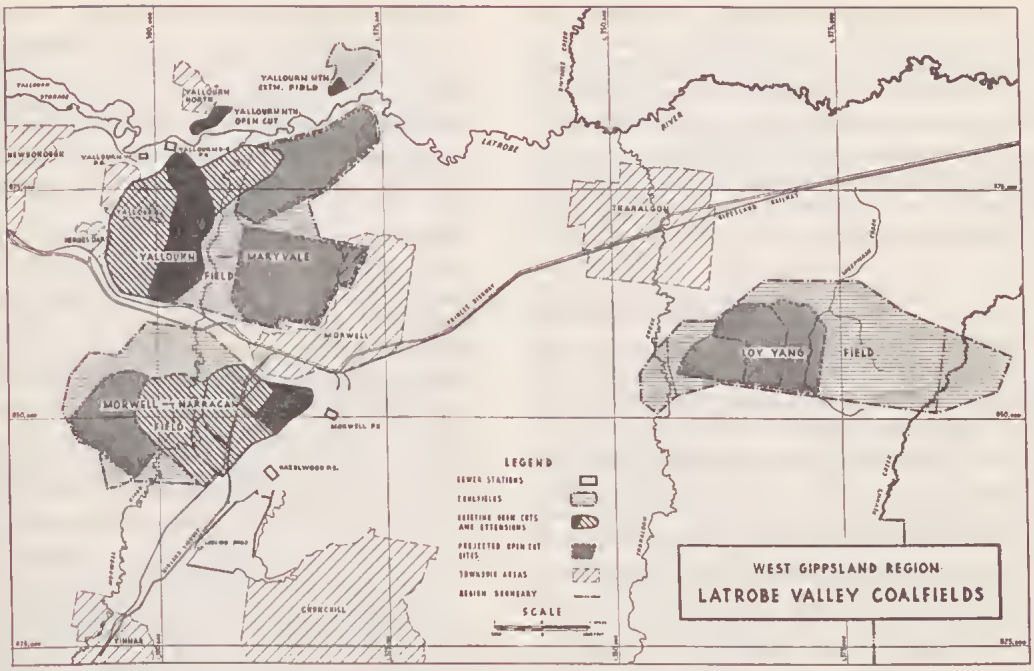
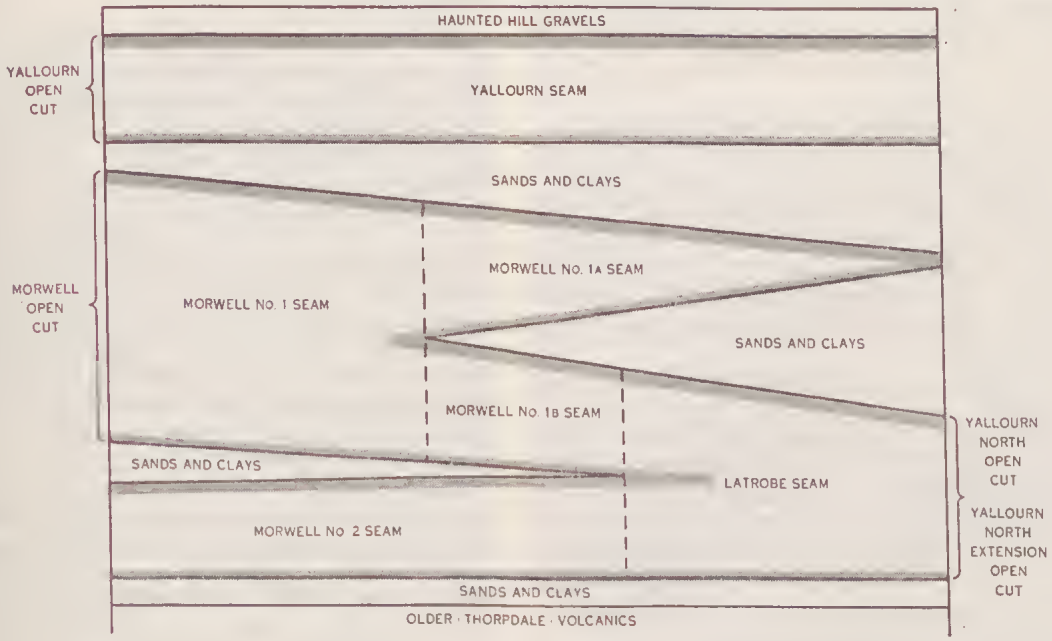


FIG. 2



DIAGRAMMATIC STRATIGRAPHIC COLUMN OF
UPPER LATROBE VALLEY COAL MEASURES
SHOWING THE COAL SEAMS BEING OPERATED
IN THE VARIOUS OPEN CUTS

FIG. 3

ond is a large outcrop in the bed and along the northern bank of the Latrobe River adjacent to the entrance to the now abandoned Yallourn North Open Cut. It is likely that both outcrops had been observed and recognized over a hundred years ago as there are records of the latter having been shown to R. A. F. Murray of the Victorian Geological Survey in 1873. The coal was analysed by J. Cosmo Newbury in 1874.

In 1891, James Stirling who was Victorian Government Geologist, with remarkable foresight told a Royal Commission on coal that he believed the Latrobe Valley deposits to be the largest in the world. At that time only limited information could have been available to him. Apart from the open cut, originally known as the Great Morwell Brown Coal Mine but finally named the Yallourn North Open Cut, which had just been opened up, and several shallow pits or adits, Murray had records of only two bores, both deep, which had been drilled in the Latrobe Valley Depression and had penetrated brown coal seams. One of these, Maryvale No. 1, was drilled near Morwell township to a depth of 1,019 ft. Six separate layers or seams of brown coal, totalling 806 ft in thickness were intersected.

A brief history of the continued interest but spasmodic development of the brown coal deposits of the Latrobe Valley during the period up to the establishment of the State Electricity Commission of Victoria in 1919 was presented by Thomas and Baragwanath (1949).

Yallourn Open Cut

The serious exploitation of the brown coal resources commenced at Yallourn in the early 1920s, with the construction by the State Electricity Commission of a power station of 75 MW capacity and a briquette factory (Chapman, 1967). A new open cut known as the Yallourn Open Cut was developed south of the Latrobe River and has been operated continuously ever since. (Fig. 2.)

In the area of this open cut the brown coal seam has an average thickness of about 200 ft with some 40 ft of soft sands and clays as overburden. Up to June 1969, the total quantity of coal won from this open cut was 282 million tons and the economic reserves remaining amount to some 450 million tons. At this time the open cut had reached a point some 3 miles south of the original opening-up point and the circumference of the cut was nearly 11 miles.

Additional power stations have been erected progressively at Yallourn and by 1963 the installed generating capacity had reached 642 MW. The original 'A' station of 75 MW was retired in 1968, and it is planned to place 'B' station, of 100 MW capacity, on cold reserve at the end of 1969 or in 1970. However, in the meantime, the construction of the 700 MW capacity Yallourn 'W' power station has commenced. This station will be completed by 1973 when the total installed generating capacity at Yallourn, based on coal won from the Yallourn Open Cut, will be 1,266 MW.

Over the period from 1925/26 to 1964/65 the annual production of brown coal from Yallourn Open Cut increased from 689,000 tons to 13,944,000 tons. In 1968/69 the production was 11,890,000 tons—the reduced quantity being more than made up for by the large increase in production from Morwell Open Cut over this period. A substantial proportion of the coal excavated at Yallourn is used for the manufacture of briquettes, and by 30th June, 1969, a total of 19,525,000 tons of briquettes had been produced by the Yallourn factories. This quantity represents more than 50,000,000 tons of raw coal.

As the retirement programme of the Yallourn Power Stations (B, C, D and E) has not yet been finally determined, the future rate at which coal will need to be excavated from Yallourn Open Cut is still indefinite. It is possible that annual production rates exceeding 18,000,000 tons may be necessary.

Morwell Open Cut

Morwell Open Cut was developed to supply the coal to Morwell Power Station (170 MW), Morwell Briquette Factory and Hazelwood Power Station (ultimate capacity of 1,600 MW). Undesirable concentration of certain inorganic constituents in the coal from this open cut resulted in boiler fouling due to the formation of bonded deposits. For this reason briquetting coal for the Morwell factory was obtained from the Yallourn Open Cut, using the 90 cm gauge interconnecting railway. The boiler fouling did result in problems in the power stations burning the Morwell coal, but as a result of intensive investigations and redesign the availability of stations has been continually increased and is now regarded as satisfactory.

Coal winning at Morwell commenced in 1957, although some small tonnages had been dug in the development stages prior to that year. By 1968/69 the quantity of coal excavated from Morwell Open Cut had increased to 10,117,000 tons, bringing the total production since opening up to 55,982,000 tons. When Hazelwood Power Station is operating to its full capacity it is estimated that annual coal requirements from this open cut could reach 17,000,000 tons.

The Morwell Open Cut was opened up in the

Morwell No. 1 Coal Seam, and, when fully developed in depth, will have a permanent batter along its northern edge, made up of about 45 ft of sands and clays overlying some 450 ft of continuous, low ash-content, brown coal. A further coal seam, Morwell No. 2, occurs at greater depth, separated from the upper seam by 50-75 ft of sands and clays, and recovery of this deep coal may be economical at some future date. The sands contain waters under artesian pressure, and in fact the area forms part of one of the coastal artesian basins of Australia. In order to ensure stability of the operating faces and permanent batters, it has been necessary to progressively lower the artesian pressures in the vicinity of the open cut. This was achieved, initially by free-flowing bores and subsequently by pumping from large diameter bores installed progressively as the open cut was developed in depth.

Yallourn North Open Cuts

The Yallourn North Open Cut was handed over to the State Electricity Commission by the Department of Mines in 1924. The coal from this cut, the Latrobe Seam, is of lower moisture content and hence of higher net heat value than the Yallourn coal. It was used for local industry but a large quantity was railed to Melbourne for use by industry and in metropolitan power stations. The deposit at Yallourn North was not large (about 12,000,000 tons) and, when excavation ceased in 1956, a new open cut known as the Yallourn North Extension Open Cut, and located about three miles further east, was brought into production to maintain the supply of this same quality coal. In 1968/69 a total of 460,000 tons of coal was excavated, bringing the total Latrobe Seam coal won by the State Electricity Commission to 20,870,000 tons. Reserves at the Extension open cut are of the order of 30 million tons.

Mining and Transport Equipment

At Yallourn Open Cut the overburden is dug by a bucket wheel dredger and is transported by conveyor into worked out areas in the open cut. The coal winning equipment consists of both bucket wheel and bucket chain dredgers. The largest of these, No. 8, is a bucket chain machine capable of digging 30,000 tons of coal per day. The coal is transported by a 90 cm gauge rail system to ditch bunkers serving the Yallourn Power Station and the briquette factories at Yallourn and Morwell.

A bucket wheel dredger also removes overburden at Morwell Open Cut. In the West Field a dredger, capable of digging 30,000 tons of coal per day, will excavate both overburden and coal; at that time the present overburden 90 cm rail system will be replaced by belt conveyors. Both bucket-wheel and bucket-chain dredgers will operate on coal which will be transported to power station slot bunkers by belt conveyors.

At Yallourn North Extension Open Cut the overburden is removed by conventional earth moving equipment and the coal is won by power shovels. After crushing, the coal is moved by belt conveyors to bins, from which it is loaded into motor transport.

Brown Coal Resources

A systematic geological investigation of the coal resources of the Latrobe Valley Depression has been carried out over many years by the State Electricity Commission. This has involved an extensive programme of drilling, sampling and analysis. The structure and stratigraphy of the Coal Measures have been established (Thomas and Baragwanath 1949-1951), Gloe (1960, 1967), and the quality of the various seams determined in some detail (Urie, Garner and Holmes, 1968).

Thick coal seams occur close to the surface in two large areas known as the Yallourn-Morwell and the Loy Yang Fields, and also in several smaller areas. Existing open cuts and possible future developments are shown in Fig. 2. The split of the Yallourn-Morwell into the Yallourn-Maryvale and Morwell-Narracan Fields, as shown in this diagram, can be made on geological as well as on geographical grounds, It will be seen that, at this stage, the large Loy Yang Field remains undeveloped.

On a geological basis the coal reserves of the Latrobe Valley deposits have been calculated as 47,500 million tons proved, and 37,300 million tons inferred. Of the proved reserves some 29,000 million tons occur with less than 100 ft of overburden overlying the uppermost seam. Selecting the most favourable areas from which sufficient coal could be won by large scale open cut operations at about present day costs, and subject to other limiting factors such as townships, essential services, rivers, etc., readily minable reserves are estimated at approximately 10,000 million tons. Additional reserves could be won at higher cost, but the amount ultimately recovered will depend on the cost of alternative fuels, on the technological advances made in methods of coal winning and power generation, etc. (Chapman, 1967).

As stated above the economic reserves remaining under the present plan of operations for Yallourn Open Cut amount to some 450 million tons. The total coal reserves in this Yallourn-Maryvale Field that could be won economically from the Yallourn Open Cut and from new open-

ings further east amount to about 2,300 million tons.

The coal reserves for the designed Morwell Open Cut east of the Morwell River are approximately 600 million tons. A further 400 million tons could be won along the river valley by a western extension of the Morwell Open Cut after carrying out a diversion of the river. For the whole Morwell-Narracan Field total economic reserves are 2,200 million tons. This includes the coal from new openings in the Narracan area, west of the Morwell River.

It will be clear that the full development of the Yallourn-Morwell Fields requires the removal of most of Yallourn Township and a major diversion of the Morwell River (Uric, Garner and Holmes, 1968).

Proven deposits of winnable coal at Loy Yang are 3,400 million tons. An area which would probably be selected for initial development contains some 1,000 million tons of very low ash-content, good quality brown coal. The deposits are of the Morwell seams with coal thicknesses up to 400 ft and an average overburden thickness of 50 ft. The development of a field of these reserves would support about 3,500 MW of new base load generating plant over a life of 40 years.

Latrobe Valley Energy Industries

(a) *Town Gas Manufacture*: In December 1956, the Gas and Fuel Corporation of Victoria commenced the manufacture of town gas from brown coal briquettes, using the Lurgi gasification process. The plant was established at Morwell and the gas transported to Melbourne by a high pressure, 18 in. diameter pipeline (Fig. 5). Since then about one third of the gas manufactured by the Corporation has been derived from this source.

With the introduction of natural gas to the Melbourne gas supply the operation of the Lurgi plant was gradually slowed down during 1969 and was finally closed down in November, 1969. At that time a total of 2,115,000 tons of briquettes had been converted to town gas.

(b) *Briquette Manufacture*: Brown coal is briquetted in order to produce a high grade solid fuel in convenient, hard lumps with a low moisture content. The briquettes have a moisture content of 15% and a calorific value of 9,600 Btu/lb —more than three times the heat value of in-situ Yallourn brown coal.

The total briquette production in 1968/69 was 1,471,600 tons of which 336,000 tons were produced at the Yallourn factories and the remainder at the newer Morwell factories. Since commencement of operations at Yallourn, 31,371,000 tons of briquettes have been manufactured.

As stated above, the use of briquettes for to gas manufacture has ceased, but an interesti prospect for a new briquette market is the man facture of briquette char. This is a coke-like for of high grade carbon, in demand for metallurgi and chemical industries. A pilot plant, initia capable of producing some 30,000 tons of ch annually, is being erected at Morwell and expected to be in operation during 1970. To pr duce this quantity of char about 65,000 tons briquettes would be required.

(c) *Electricity Generation and Transmissio* By 1969 the generating capacity installed in t Latrobe Valley made up 59% of the total capac installed for the State, and in 1968/69 the outp from the Latrobe Valley power station suppli 85% of the State's electricity requirements.

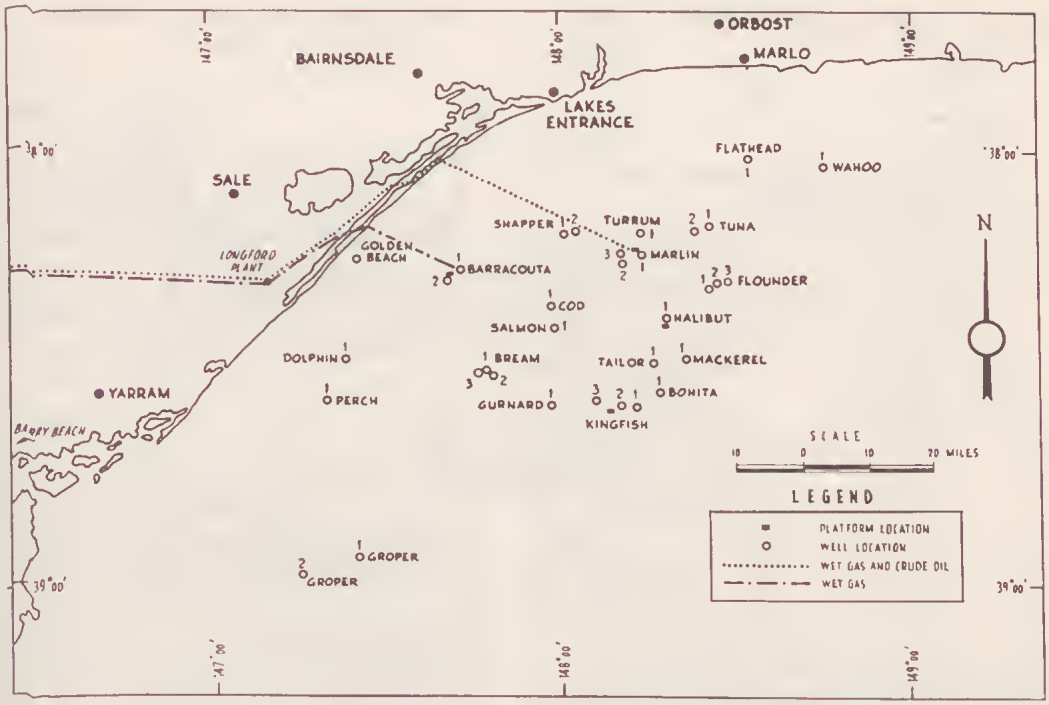
The continuously increasing power generati in the Latrobe Valley has been associated wi development of transmission capacity of the c cuits delivering power to Melbourne. The origin 132 kV lines have been overlaid with 220 k transmission and there are now three double c cuit steel tower lines operating at this voltage ov the 90 miles distance to Melbourne (Chapma 1967). Lines to operate at 500 kV are now bei constructed. One has been completed but is bei operated at 220 kV. It will be converted to 5 kV in 1971 when the second line is complet (Fig. 5).

Gelliondale

The Gelliondale brown coal field (see Fig. 1) located on the flat coastal plain between Gellio dale and Hedley and extending towards the coa The bulk of the coal, with less than 100 ft overburden, lies between the northern slope of buried ridge of Mesozoic sediments and the l Mesozoic foothills to the north of Gelliondal Coal at shallow depth has been proved for area roughly seven miles long by one mile wi The seam is about 250 ft in thickness but son bores to the south-east show thicknesses of to 400 ft. The moisture content of this coal rang between 60% and 70% and probably averag about 1% higher than Yallourn Open Cut co Ash contents are rather high and probably ave age more than 5% on a dry basis.

A small open cut was operated on this field 1923. A plant for drying and briquetting the co was installed, but worked only intermittently an finally ceased.

Values calculated by the Victorian Departme of Mines indicate total geological reserves about 1,000 million tons. The main block of th coal is centred on the open cut and contains son 500 million tons. Economic mining reserves a likely to be considerably less.



GIPPSLAND BASIN – OIL & GAS RESOURCES – LOCATION OF OFFSHORE WELLS

FIG. 4

WONWRON

A small deposit of just over 2 million tons of good quality coal occurs about nine miles north of Yarram (see Fig. 1). The coal was first recorded in Middle Creek in 1876, where it was exposed in the creek bed. Although bores have shown the seam to reach a thickness of 220 ft, only thin splits occur in surrounding areas.

THORPDALE-CHILDERS

Brown coal seams of the Childers Formation, and up to 20 feet thick, underlie flows of Older Basalt in the Thorpdale district, and have been known since before 1890. These deposits have been worked at a number of localities by means of adits. The coal was of good quality and was used by local industry. The biggest of these operations was at the Moolamoona Mine (see Fig. 1) where upwards of 58,000 tons was produced by bord and pillar mining methods. Operations ceased several years ago as the coal could not compete in price with that won by mechanized methods in the Latrobe Valley open cuts.

OIL AND GAS

Minor shows of oil and gas have been obtained from several of the exploration wells drilled in the West Gippsland Region. These wells were located along the Ninety Mile Beach. However, far more spectacular and successful results have been achieved from the offshore wells drilled by Esso Exploration Australia Inc. as part of their farm-out agreement with Hematite Petroleum Pty. Ltd. (Fig. 4). While the major oil and gas field discovered by them in the thick sands of the Latrobe Valley Coal Measures is not located within the West Gippsland Region, some of the development and exploitation of these new resources will take place within the boundaries of the Region adopted by this Symposium.

A brief summary of results obtained since the first bore was drilled in 1965 is set out below. Within Victorian waters a total of 30 exploratory wells have been completed and two are in progress.

BARRACOUTA FIELD: a gas field estimated to contain 1½ to 2 million million cu. ft of gas and 30 to 50 million barrels of condensate liquid. Oil has been discovered at a lower level and is to be developed for commercial production.

MARLIN FIELD: a gas field which has double the gas reserves indicated for Barracouta and is also somewhat richer in condensate. It contains some oil but reserves have not been assessed. No drilling has been carried out from the Marlin platform since a major blowout occurred in December

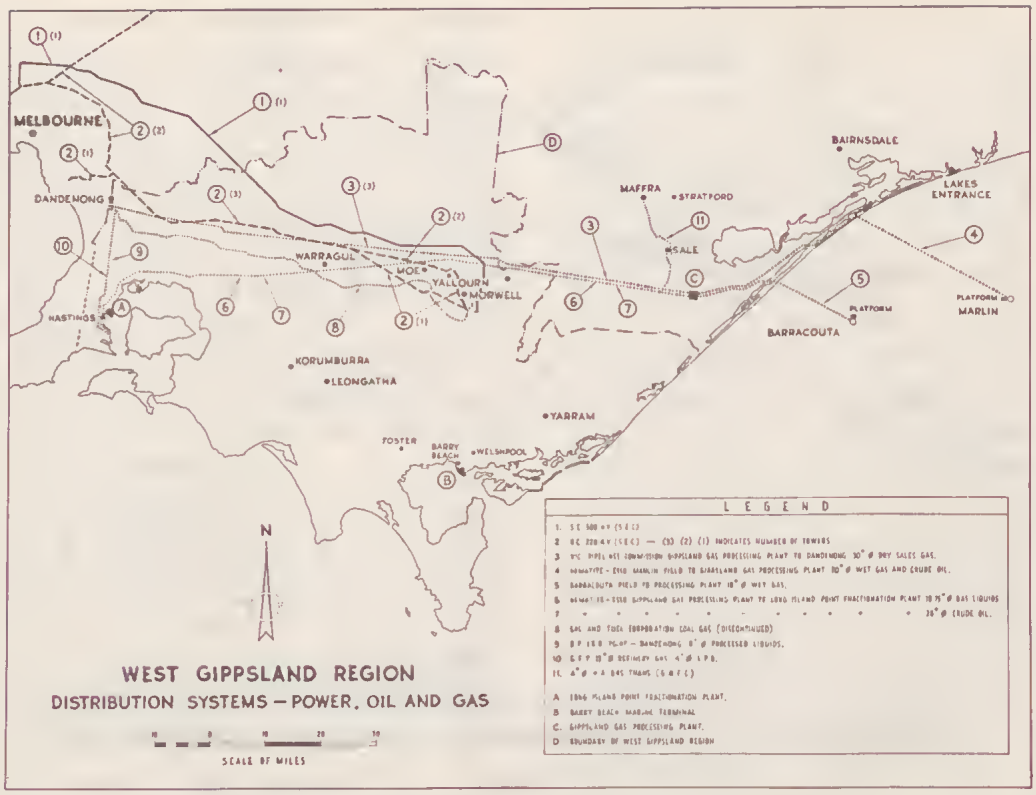


FIG. 5

1968, which was brought under control some four weeks later.

KINGFISH FIELD: an oil reservoir with reserves estimated at 1,060 million barrels. Two production platforms are being erected.

HALIBUT FIELD: an oil reservoir with reserves estimated at 440 million barrels. One production platform has been erected and development drilling is in progress.

OTHER FIELDS: drilling on the Tuna, Snapper and Flounder structures has indicated significant oil and gas occurrences which are currently being assessed.

Pipelines from Barracouta and Marlin Platforms to the Longford gas processing plant and from there to Dandenong and the Long Island Point Fractionation Plant are shown (Fig. 4 and 5).

Golden Beach 1A well was drilled about 16 miles west of Esso's Barracouta A1 well for an alliance of five oil companies including Woodside Oil Co. N.L., the original leaseholder. Gas was discovered on a structure somewhat smaller than the Barracouta structure and its economic potential is still under study.

PUMPED STORAGE HYDRO-ELECTRIC POTENTIAL

A preliminary investigation of undeveloped peak generating capacity from hydro-electric sources in Victoria has indicated that there are a number of potential pumped storage projects in the West Gippsland Region. One of the two most favoured in this area is on the Latrobe River and has a generating head of 1,150 ft. The other scheme is located on the Thomson River where an approximate head of 1,750 ft is available (Fig. 1).

SUMMARY

One of the largest deposits of brown coal in the world provides the basis for the power and fuel complex which has been developed in the Latrobe Valley. Already about 85% of the State's electricity requirements are derived from this source, and ample reserves are available for future expansion.

As a result of the recent discoveries of large reserves of oil and gas in the offshore portion of the Gippsland Basin, important additions have been made to the State's indigenous fuel resources. These reserves are likely to be increased

as drilling continues and will have to be taken into account in future planning of power generation projects.

ACKNOWLEDGMENTS

The author wishes to thank the State Electricity Commission of Victoria for its permission to present this paper. Much use has been made of papers written by other officers of the Commission, in particular, *The Latrobe Valley Power and Fuel Complex* by R. G. Chapman in 1967. The author also acknowledges data supplied by officers of the Victorian Mines Department regarding the black coal, and oil and gas resources.

REFERENCES

Chapman, R. G., 1967. The Latrobe Valley Power and Fuel Complex. *Paper presented to Inst. of Eng. at Yallourn (unpublished)*.

Edwards, A. B., Baker, G. & Knight, J. L., 1944. The Geology of the Wonthaggi Coalfield, Victoria. *Proc. Aust. Inst. Min. Met.*, 134, Vol 1: 1-54.

Gloe, C. S., 1960. The Geology of the Latrobe Valley Coalfield. *Ibid.*, 194: 57-125.

———, 1967. The Brown Coals of the Latrobe Valley. ANZAAS 39th Congress, Melbourne, Excursions Handbook, Section C, 1967: 195-200.

Thomas, D. E., 1968. Physiography, Geology and Mineral Resources. In *Victoria. Central Planning Authority. Resources Survey, West Gippsland Region*. Govt. Printer, Melbourne, 1968: 24-42.

———, & Baragwanath, W., 1949-51. Geology of the Brown Coals of Victoria. *Min. geol. Jour. Vic.*, 3(6): 28-55; 4(1): 36-52. 4(2): 41-63; 4(3): 36-50.

Urie, R. W., Garner, L. J., & Holmes, D. S., 1968. The Evaluation of Victorian Brown Coal Resources for Future Power Projects. *Aust. Inst. Engr., Mech. & Chem. Engng. Trans.* Nov. 1968: 197-206.

Appendix 1

Fuel and Power Statistics—Latrobe Valley

	1968/69	Total to Date
Brown coal production—million tons		
Yallourn North Open Cut	—	20·87
Yallourn North Extension Open Cut	0·46	
Yallourn Open Cut	11·89	282·08
Morwell Open Cut	10·12	55·98
Total coal production	22·47	358·93
Briquette Production—million tons		
Yallourn Factories	0·34	19·52
Morwell Factories	1·13	11·85
Total briquette production	1·47	31·37
	1969	1974 (estimate)
Installed Generating Capacity MW		
Yallourn Power Station	566	566
Morwell Power Station	170	170
Hazelwood Power Station	1,200	1,600
Yallourn 'W' Power Station	—	700
Total installed capacity	1,936	3,036